# Decentralization in Colombia: Searching for Social Equity in a Bumpy Economic Geography

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**Abstract**

Colombia's decentralization was conceived to improve population's access to social services, reduce poverty and equalized well-being across the territory. However, after more than 20 years of its implementation a big gap across municipalities still remains. This paper examinees the determinants of multidimensional deprivation in social outcomes across municipalities; in particular, we analyse the impact of a decentralization process based on the delegation of delivery of social services coupled with increasing subnational transfers from the Central Government, over the achievement of social minimums as depicted by the average multidimensional gap and the multidimensional deprivation headcount. We use an instrumental variable approach to account for the endogeneity that arises when evaluating the impact of fiscal decentralization over multidimensional deprivation; at the same time we take into account the spatial interrelation of deprivation across municipalities by implementing a spatial autoregressive model with spatial autoregressive disturbance. We find strong statistically significant results across all the proven specifications that confirm: first, spatial spillovers of deprivation across municipalities that need to be taken into account when designing public policy interventions; second, causal diminishing effect of fiscal decentralisation over the multidimensional deprivation headcount ratio and gap. Counterfactual scenarios of spatially differentiated decentralization policies highlight their grater effectiveness over geographically mute designs.

**Keywords:** Decentralization, multidimensional poverty, equity, economic geography, spatial interdependence, Latin America, Colombia

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## 1. Introduction

Colombia's decentralization was conceived to improve population's access to social services, reduce poverty and equalized well-being across the territory. However, after more than 20 years of its implementation a big gap in social achievements across municipalities remains. According to 2005 census calculations, 55.6% of the national population is under multidimensional poverty with astonishing differences across municipalities ranging from 19.8% to 99.8%.[1]

Several studies have tackled the divergent economic pattern of Colombian territories over time, such as Cardenas (1993), Bonet and Meisel (1999), Acevedo (2003) and, more recently, Cortés and Vargas (2012) among others; however, most of them focus their analysis on economic convergence and their unit of analysis is *´departmentos´* (Colombian counties). In this paper we focus on convergence to social minimums at the municipality level, the smallest political – administrative unit in Colombia.

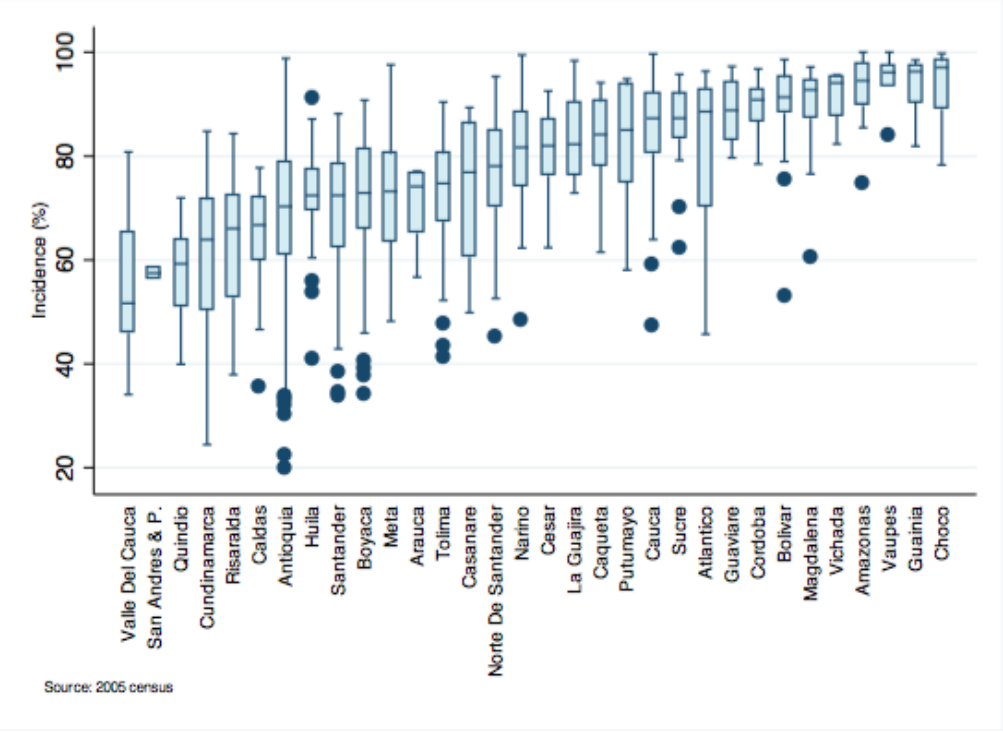
This choice is not irrelevant: one of the key insights of this study is that poverty needs to be understood taking into account its spatial dimension, where economic geography features and institutional capabilities of local governments play a crucial role. Therefore, for the Colombian case addressing the geographical dimension of poverty at the county level hides the high heterogeneity that lies inside counties. For instance, when plotting the dispersion of multidimensional poverty incidence across Colombian municipalities and by county, as is showed in Figure 1 below; most of the counties register a large dispersion, having counties, as for example Antioquia, with municipalities from 19.7% of multidimensional poverty (Envigado) up to municipalities with 98.8% of multidimensional poverty (Vigía del Fuerte).

We argue that rather than economic convergence, where differences across the territory are explained and even desirable because of agglomeration processes and external economies arising from urbanization, the claim should be for convergence to social minimum achievements that allow the population to fulfil their life with valued functionings[2], which is the ultimate goal of the "Social Rule of Law State" (*Estado Social de Derecho*) specified by the 1991 Colombian Constitution.

[1] The Colombian Multidimensional Poverty Index (CMPI) is the national indicator of multidimensional poverty launched by the Colombian government in 2012. This indicator sets the socially acceptable minimums for the five most important Colombian social public policy dimensions (education of household members; childhood and youth conditions; health; employment; and access to household utilities and living conditions) (Angulo et al, 2013). Figures correspond to our census based calculations and version of the CMPI (See section 5.a for a broader description on this indicator).

[2] According to Sen (1993) approach to well-being and advantage, the life that a person held can be seen as a finite set of doings and beings, some very basic and strongly valuated and other more complexes. Those various doings and beings are called by Sen as *functionings.*

**Figure 1: Dispersion of multidimensional poverty headcount by county**




In fact, the "decentralization model" conceived by the Constitution of 1991 can be understood as a rearrangement of the State and the relationships between levels of government to achieve social equity. The objectives of decentralization as stated in the Constitution are: a) to improve the access of the population to social and public services, with emphasis in education, health, water supply and sanitation; b) to target resources toward the poorest population in order to take them out of poverty; c) to diminish territorial inequalities; d) to promote productive processes to improve income and employment, and e) to improve and to deep representative and political democracy (Maldonado, 2011).

In this context, there is a particular strand within the decentralization literature that explores the relationship between poverty and decentralization, trying to establish whether or not the decentralization process has served the poor. Studies within this strand at the international arena use cross country panels but are still inconclusive or contradictory; examples of those are Von Braun and Grote (2000) and Sepulveda and Martinez (2011). This study focus on 34 developing countries with information from 1970 to 2000 and they find that the share of income of local governments over the national income has a negative and statistically significant effect over the monetary headcount poverty ratio; however they do not control neither for political nor administrative decentralization as was found by Von Braun and Grote (2000) to be key when trying to disentangle the effects of decentralization over poverty.

On the other hand, within the Colombian case literature, two papers approach the fiscal behavior of local governments under the Colombian specific decentralization design: Perry and Olivera (2009) and Sánchez and Pachón (2013). Whereas Perry and Olivera (2009) explore the relationship between "fiscal

effort" and royalties from coal and oil and found that in some cases the increase in royalties has reduced the fiscal effort of some local governments; Sánchez and Pachón (2013) assess the causal relationship between political competition and "fiscal effort" and found that indeed political competition variables are related with the Colombian municipalities' "fiscal effort", and that the size of this effort affects the efficiency in the provision of water and education services.

Therefore, our empirical contributions within the decentralization literature rely on: first, the assessment of the causal effect of the Colombian municipalities' "fiscal effort" over multidimensional deprivation, taking into account not only the fiscal feature of the decentralization but also its political and administrative perspective; second, we address multidimensional deprivation as an economic geography phenomena and the effect of the decentralization process to overcome those economic geography issues that emerge from a very heterogeneous territory. To do that, we use 2005 census data and several administrative registers from Colombian agencies on household social conditions, social public expenditures and others. With this information, we use a spatial econometric approach in order to model multidimensional deprivation headcount and gap. We implement an instrumental variable approach to account for the possible endogeneity that could arise when evaluating the impact of fiscal decentralization over multidimensional deprivation.

From our analysis we derive policy implications to improve social convergence to minimums and equal opportunities for all citizens despite where they were born or where they live. Results suggest a causal diminishing effect of fiscal decentralization (measured by the per capita rate of own generated resources) over the multidimensional deprivation headcount and gap. We find a strong statistically significant effect of spatial spillovers of deprivation across municipalities that need to be taken into account when designing public policy interventions. Additionally, we test counterfactual scenarios of spatially differentiated decentralization policies and they highlight the greater effectiveness of such type of public policies over geographically mute designs. Spatially differentiated decentralization policies that take into account the heterogeneity of regions and municipalities are definitely required in order to improve social convergence to minimums.

The paper is organized as follows: first Section two, below, describes the data sources that we use for our analysis. Section three describes the decentralization model in Colombia and the measures that we propose to describe it. Section four, analyses the relationship between decentralization and social equity that emerge for the Colombian case. Subsequently, at Section five, we describe our approach to measure social equity within each municipality. Section six, in turn, conceptualize how, for the Colombian case, economic geography plays a very important role when trying to understand the channels that produce deprivation at the local level. After this, we proceed to describe in Section seven the empirical strategy that we pursue and the econometric results that we obtain from it. Finally, Section eight outlines limitations and concluding remarks that can be derived from this particular analysis.

## 2. Data

Since we seek to analyze decentralization at the municipality level, we built a municipality database based first, on estimations from 2005 population and housing census and, second, on Colombian administrative registers.

The 2005 population and housing Colombian census interviewed 10.4 million households for a total of 41.5 million persons. The Census was intended to cover all the national territory and according to a post-censal assessment had an overall estimated coverage of 96.3% of the total population. The population and housing Census was made mainly of two questionnaires, the first one applied over each of the respondent households including dwelling conditions and household composition questions. The second questionnaire, an extended version of the first one, was applied over a probabilistic subsample of conglomerates with a household Bernoulli selection procedure. The extended questionnaire included information regarding education and labor conditions for each of the household members and allows for municipality figures estimations.

On the other hand, regarding Colombian administrative registers we use: i) the local budgetary execution register from the National Planning Department[3]; ii) the 2003 national registers on voting from the National Registry Department; iii) primary and secondary road network information from the System of Cities and from the National Geographical Institute (IGAC); iv) administrative register regarding social protection affiliation for formal employees from the Social Protection Ministry; and v) demographic indices from the Colombian UNDP 2011 report (Machado, 2011).

## 3. Decentralization in Colombia: A Model of Delegation financed by Governmental Transfers

The fundamental core of decentralization from a fiscal federalism model rests in the definition of competences to different levels of government, and in the allocation of resources that enable local governments to exert those competences. According to Martinez-Vazquez and Timofeev (2009) decentralization could be defined as the process of transferring decision power to the lower levels of government. Then, decentralization, in general, can be understood across three main areas were local governments are empowered: fiscal, administrative and political.

The ideal model of fiscal decentralization, embedded in the so called “fiscal federalism” (Litvack et al., 1998) proposes fiscal independence of each jurisdiction over the basis of a distribution of incomes and responsibilities. In practice however, the degrees of decentralization vary. The usual models of

[3] Information system for capturing the local budget execution (*Sistema de Información para la Captura de la Ejecución Presupuestal,* SICEP)

decentralization can be put into three schemes: a) deconcentration of national agencies that imply some autonomy with control and regulation from the central government; b) delegation, for which the subnational government is able to supply some social services, under the regulation of the central government; c) devolution, which implies full autonomy in terms of competences and with the ability to generate the resources needed to exert those competences.

While devolution implies that municipalities take over the provision, financing and regulation of public services; delegation and deconcentration do not imply municipalities self-regulation of the public services provision. Moreover, deconcentration only takes part in the public services provision but neither in their financing nor in their regulation.

The current state of decentralization in Colombia is the result of 25 years of accumulation of major reforms that began with the Legislative Act (AL) No. 1 of 1986 and extend through the reforms of royalty and territorial planning in 2011-2012. Since the beginning it was recognized that fiscal federalism was not a possibility for the large group of municipalities that lacked sources to generate their own income and that the model of fiscal federalism only could be applied, if any, to cities (Bird, 1981). The recognition of vertical and horizontal imbalances led to the design of a transfer system that would allow subnational governments to achieve the main objectives of decentralization.

Therefore, the Colombian decentralization is in practice, an eclectic model of decentralization, deconcentration and delegation strongly funded by subnational transfers from the Central Government. As Bird (2012) states, “it may now be argued that Colombia’s real model of decentralization is perhaps best characterized as one of delegation rather than devolution”. In the discussion between “devolution” and “delegation” model there are, however, important sectorial differences. For example: (i) In water supply and sewerage the system is decentralized (all the investment decisions are responsibility of subnational governments), while resources come from transfers and own resources (price charges and royalties). The recent scheme of Departmental Water Plans can be considered as a change in competences between municipalities and departments. The new scheme gives more responsibilities to departments mainly due to economies-of-scale arguments. (ii) Health services are also fully decentralized: departments and municipalities have full autonomy for budgeting and managing their own resources but this is constrained to previous certification to enable the territorial administrations for that regard. (iii) In education the scheme is more of delegation than devolution.

This model has been consistently nuanced with elements of coordination and concurrency which are becoming stronger. Since the Constitution of 1991 and Law 60 of 1993, the resources of the General System of Transfers, (*Sistema General de Participaciones*, SGP by the Spanish acronym), were earmarked to certain sectors, mainly education, health services and water supply and sewerage. The use of resources usually has been guided and monitored by the national government, in some cases with a certification from the central government of sub national governments’ skills to provide these services.

According to 2010 governmental figures, in education, health services and water supply and sewerage around 90% of public investment is responsibility of sub national governments. Between them, municipalities have played a lead role in the decentralization process, while departments have

played a secondary role. Out of the total public investment budget, 47% was executed by the municipalities, 22% by the counties and 31% by the national or central level. The share of sub national Governments is even more important in the case of social investment[4] (Table 1 within the Annexes report the 2010 Colombian governmental investment structure by levels of government).

### a. Measuring Colombia's decentralization

As stated before, decentralization is understood across three complementary levels: fiscal, administrative and political, we explain below our measurement approach to each of those levels.

*Fiscal decentralization:* according to the Colombian decentralization design, we measure the three most important features of fiscal decentralization: i) the taxation ability of each municipality, ii) the dependency of each municipality from the central government, and iii) the financing degree of each municipality upon royalties. The limited fiscal decentralization in Colombia is reflected in the fact that, on average, the share of own resources over the total is just 12% across municipalities, although there are some municipalities with a share around 80%. This result reflects the importance of governmental transfers to subnational governments. On the other hand, royalties, in 2005 represented an important source of revenues for around 150 municipalities in which the production of minerals and hydrocarbons was important. Despite that on average, they are not as important as transfers, for some municipalities they represented up to three times the size of the maximum transfers coming from the central government[5]. As shown in Table 2 below, these three features of the fiscal decentralization were measured per each municipality as the per capita amount of investment that become from such source.

*Administrative decentralization:* It is approached with an indicator of administrative capacity, which ranges between 0 and 100. This indicator was calculated by the National Planning Department and takes into account the stability of top (non-elected) officials, educational attainment of local administration employees, relative use of information technologies, degree of process standardization, auditing capacity and internal control system performance.

*Political decentralization:* one of the main objectives of the Constitution of 1991, is measured by the share of total votes for departmental candidates ("*Asamblea*") from the electoral potential. Those are taken from the elections hold in 2003. The reason not to use directly the votes for municipal candidates

[4] Social investment in this case refers to CMPI related investment; which includes Education, Health, Attention to vulnerable groups, social promotion, Dwelling, Drinking water and basic sanitation, and Public services different from water and sanitation.

[5] With the constitutional reform to royalties in 2011, the distribution of these resources among subnational governments changed drastically. With the former regime 20% of municipalities and counties received 80% of royalties; with the new regime their share will decrease to 20% after a transition period.

was the large number of missing values for that year due to violence and the presence of illegal armed groups that prevented elections to take place[6].

**Table 2. Descriptive statistics: decentralization variables**

| Decentralization | | N | Mean | Std. dev | Min | Max | Units | Source |
|---|---|---|---|---|---|---|---|---|
| Fiscal | Taxation capability, 2003: per capita own revenue resources | 1094 | 47.24 | 63.97 | 0.00 | 719.44 | Per capita thousand pesos | SICEP-2003, National Planning Department (NPD) |
| | Per capita investment financed by SGP, 2003 | 1094 | 214.70 | 132.57 | 0.00 | 1063.45 | | |
| | Per capita investment financed by royalties, 2003 | 1094 | 29.58 | 166.91 | 0.00 | 3838.00 | | |
| Administrative | Administrative ability | 1098 | 51.66 | 18.84 | 0.00 | 85.48 | Index that ranges from 0 to 100 | NPD (Overall performance index) |
| Political | Share of total votes over electoral potential, 2003 | 1111 | 58.00 | 14.40 | 0.20 | 96.4 | Percentage share (0-100) | National Registry Department |

## 4. The relationship between decentralization and social equity

The main argument that justifies decentralization as a tool for the achievement of social goals lies in the premise that decentralization allows the revelation of local preferences, makes possible a more adequate supply of social services and basic goods to the conditions and necessities of local populations and put citizens in direct relationship with the level of government in whose election they participate, and over whom they can exert a closer accountability.

However, while the level of accountability can improve with decentralization and therefore the delivery of goods and services for the poor can be more effective than with a centralized system, it is also true that local governments are prone to be politically captured by local interest groups that distort and divert resources to their own interests. For instance, Bardhan and Mookherje (2005), develop a

[6] In 2002, almost one third of the municipalities elected majors could not perform from their offices because of risks arising from the presence of these illegal armed groups that had control, at that time, over important parts of the territory.

model that addresses the relationship between decentralization and the provision of social services and accountability in government service delivery. In their model the potential political capture at local government, is crucial to determine the effect of centralization or decentralization on the welfare of the poor population. According to their model, when there is no capture at any level, the decentralized model behaves better and allows achieving a second best outcome characterized by cost effectiveness and targeting on the poor. However, with a sufficiently large extent of local capture, the decentralization model fails and the centralized solution is more appropriate.

Although it could be argued that political capture by interest groups is more likely to be higher in municipalities with higher poverty rate and higher inequality, bureaucrats at the Central Government can also be captured by local interest groups and corruption might arise as a consequence of lack of monitoring and supervision. Indeed, Sanchez and Pachón (2013), when empirically addressing the Colombian case, found a positive effect of electoral competition, both national and subnational, on fiscal capacity.

On the other hand, beside political inefficiencies of the decentralization system, the relationship between decentralization and social outcomes is yet not univocally determined. We argue at least two reasons that drive this complex relationship. First, since most of the transfers from the central government to the municipalities are defined based on municipality poverty criteria, it could be argued that the most deprived municipalities are therefore more dependent on governmental transfers and have less incentive to increase their share of own generated resources. As second argument, it could be stated that since the most deprived municipalities have actually a smaller base of population and business that contribute to the municipality revenues, they actually have less ability to pay taxes. Therefore, the per capita own resources (as our gold standard fiscal decentralization indicator) and the deprivation at the municipality level might hold a double causality relationship.

Moreover, we hypothesized that the relationship between decentralization and deprivation at the municipality level is endogenous, not only because its double causality relationship but also because there are factors such as non-observable political forces and elites dynamics at the regional level, which are related to decentralization but that indeed we are not able to observe.

## 5. Operationalizing social equity

To evaluate the relative degree of success of decentralization in Colombia to achieve its ultimate goal, which is the improvement to the population's access to social and public services and the reduction of territorial social inequalities in Colombia, we use the Multidimensional Poverty Index (CMPI) at municipal level.

The CMPI is a national indicator that sets the socially acceptable minimums for the five most important Colombian social public policy dimensions (household's educational condition; childhood and

youth conditions; health; labor characteristics; and access to household utilities and living conditions) and is able to capture how far from each minimum is each household (Angulo et al., 2013). The CMPI was launched by the National Planning Department in 2012, based on the Alkire and Foster (2010) method for multidimensional poverty indices; it uses as unit of analysis the household and aggregates 15 indicators among those five most important social dimensions. One interesting feature of the CMPI is that all the indicators that compose the index could be potentially affected by public policies and social investment.

The identification and aggregation method that the CMPI follows allow to use, first a multidimensional deprivation headcount ($H$), and second an average poverty gap ($M1$), both of them as the average at the household level across municipalities. The multidimensional deprivation headcount ($H$) depicts the share of the population that is considered within each municipality as multidimensionally deprived population under multidimensional deprivation for this indicator is the one with more than 33% of the weighted sum of the considered variables in situation of deprivation.

On the other hand, the average poverty gap ($M1$) informs the average gap to reach the achievement levels set as minimums. In particular, we use $M1$ as an opposite measure of convergence to social minimums because it expresses how distant each household is from each of the dimensional poverty lines. For a comprehensive description of this counting methodology for multidimensional poverty see Alkire and Foster (2010).

The original CMPI was conceived using the Colombian Living Conditions Survey; however, since such survey do not allow for estimations at the municipality level; we opt for implementing the CMPI using 2005 census individual data[7]. Table 3 below describes the dimensions, variables, cut-off points and weights per variable of the CMPI indicator that can be calculated based upon 2005 census data.

[7] The official methodology to calculate the CMPI uses the 2003, 2007 and 2010 Colombian Living Conditions Survey (CLCS); for a complete description of such official CMPI see Angulo et. al. (2013). The CMPI that we implemented have two minor differences with respect to the official CMPI: the first source of difference is given by slightly differences in the wording of some of the 2005 census questions and CLCS questions and also the absence of some particular questions that the CLCS uses. The second source of differences is given by the expression of some of the indicators of the household education conditions and access to public utilities and housing conditions to be able to depict the full set of indicators in a cardinal scale – that is, it requires each of the indicators to be measured on a scale with meaningful value of the difference between two points, rather than just indicating the presence or absence of a certain attainment. For a complete description of the methodology to construct the 2005 census based CMPI that we use and the transformations done over the official CMPI see Ramirez et. al. (2013).

**Table 3. Dimensions, variables, weights and cut off points of the implemented CMPI**

| Dimension | Variable | Indicator | Cutoff point |
|---|---|---|---|
| Household education conditions (0.2) | Educational achievement (0.1) | Percentage of people living 15 and older who holds at least 9 years of education | 100% |
| | Literacy (0.1) | Percentage of people living in a household 15 and older who know how to read and write | 100% |
| Childhood and youth conditions (0.2) | School attendance (0.05) | Percentage of children between the ages of 6 and 16 in the household that attend school | 100% |
| | No school lag (0.05) | Percentage of children and youths (7–17 years old) within the household that are not suffering from school lag (according to the national norm) | 100% |
| | Access to childcare services (0.05) | Percentage of children between the ages of 0 and 5 in the household who simultaneously have access to health, nutrition and education | 100% |
| | Children not working (0.05) | Percentage of children between 12 and 17 years old in the household that are not working | 100% |
| Employment (0.2) | Absence of long-term unemployment (0.1) | Percentage of household members from the economic active population that are not facing long-term unemployment (more than 12 months) | 100% |
| | Formal employment (0.1) | Percentage of employed household members that are affiliated to a pension fund (formality proxy) | 100% |
| Health (0.2) | Health insurance (0.1) | Percentage of household members over the age of 5 that are insured by the Social Security Health System | 100% |
| | Access to health services (0.1) | Percentage of household members that had access to a health institution in case of need | 100% |
| Access to public utilities and housing conditions (0.2) | Access to dwelling services (0.1) | Percentage of dwelling services that the household has access to; this out of (i) water source, (ii) elimination of sewer waste, (iii) adequate external walls* (iv) adequate floor++. | 100% |
| | No critical overcrowding (0.1) | Percentage of absence of critical overcrowding** | 100% |

**Source**: Angulo et al (2013) and Ramirez et al (2013). **Notes:** The weight assigned to each dimension and variable is shown in parenthesis. *Urban households are considered deprived in water source if they are lacking of public water system. In elimination of sewer waste if they lack a public sewer system. In adequate external walls if the exterior walls are built of untreated wood, boards, planks, guadua or other vegetation, zinc, cloth, cardboard, waste material or when no exterior walls exist. Rural household are considered deprived in water source if the water used for the preparation of food is obtained from wells, rainwater, spring source, water tank, water carrier or other sources. In adequate elimination of sewer waste if they use a toilet without a sewer connection, a latrine or simply do not have a sewage system. In external walls if the exterior walls are built of guadua or other vegetation, zinc, cloth, cardboard, waste materials or if no exterior walls exist. ++Households (both urban and rural) with dirt floors are considered deprived in adequate floor. ** Deprivation is considered for: urban households with three or more persons per room or rural households with more than three persons per room.

## 6. The economic geography's role when explaining social equity in Colombia

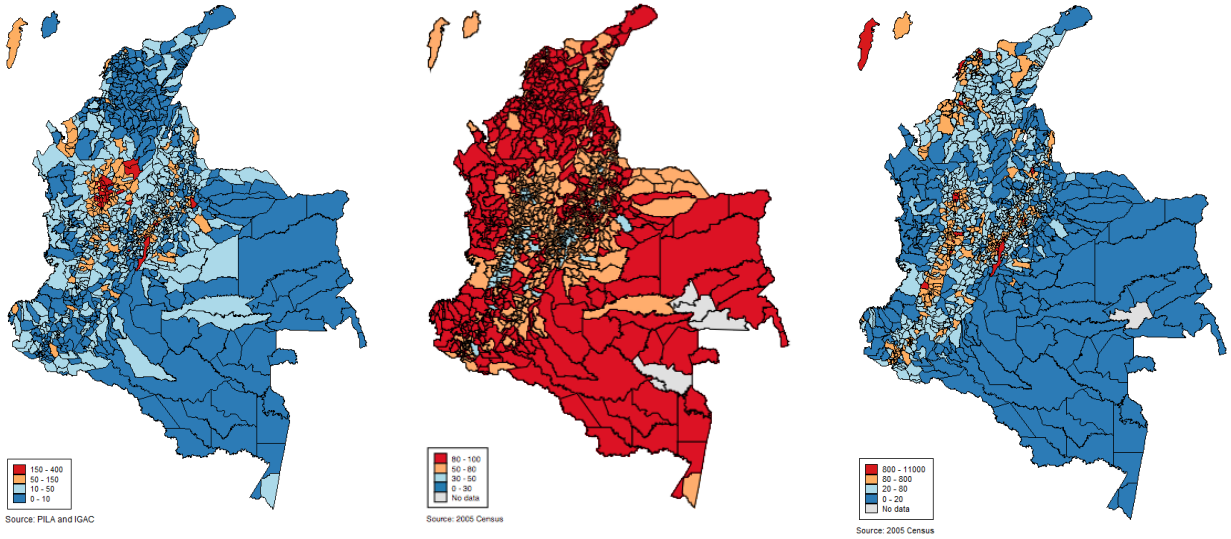
In this section we conceptualize how, for the Colombian case, economic geography plays a very important role when trying to understand the channels that produce deprivation at the local level.

According to Harvey (2009) findings, we can state that spatial distribution of economic activities tends to be unequal and concentrated in some geographical areas as a result of market forces of agglomeration, labour migration and specialization. Economic density is, therefore, a common characteristic of economic growth. Densification of economic activities goes at hand with densification of population (although the opposite not necessarily takes place, or not necessarily at the same pace). These endogenous dynamics imply a more efficient spatial structure of production with gains in terms of economic growth, productivity and income generation. Colombia is not an exception. As Figure 2.a below shows, the largest number of formal businesses per squared kilometer is concentrated in Medellin and Bogota and their metropolitan areas, with 285 and 191 businesses per urban kilometer, respectively. As could be expected from an economic geography perspective, areas with higher economic density might become the ones with lower income poverty, since they concentrate the main economic activities, have a larger proportion of formal labor, and therefore higher wages and per capita labor incomes. In this sense, cities, as the geographical space with higher economic and population densities play a potential key role in the reduction of deprivation. Comparisons of Figures 2.a and 2.b, suggest that agglomerations that concentrate the highest number of businesses per squared kilometer register, at the same time, the lowest rates of multidimensional deprivation headcount; as is the case of Bogota and Medellin.

On the other hand, areas with more disperse population tend to have higher deprivation headcount, not only in income terms, but also in multidimensional terms. Population dispersion implies higher transportation costs and it makes more difficult the provision of infrastructure and public services, and the access to technology, education and health services, lowering the quality of these services as well. Figure 2.c shows differences in population density across the Colombian territory. It suggests that less dense areas show indeed greater multidimensional deprivation headcount (Figure 2.b).

Actually, for the Colombian case, as Samad et al (2012) argued, urbanization might have generated higher social inclusion across municipalities: in 1964 there were huge gaps in access to public services between population living in large cities and urban population in small municipalities; those gaps have almost disappeared after five decades. While in 1964 only Bogota registered an average share of population with access to electricity, water and sanitation greater than 75%, in municipalities with less than 20 thousand inhabitants less than 30% of them had access to those services; in 2005 the average share of urban population with access to those services for any group of municipalities is greater than 80% (Figure 3 within the Annexes displays, in detail, the evolution in dwelling services coverage between 1964 and 2005 by size of municipality, for the population living in the urban areas).

**Figure 2. Spatial distribution of economic activity, deprivation and density**




a) Business per urban squared kilometre

b) Multidimensional deprivation headcount (H)

c) Density (Inhabitants per squared kilometre)

Urbanization can also have a significant effect reducing rural poverty. Studies such as Cali and Menon (2009) found causal effect of urbanization over poverty reduction in the surrounding rural areas of Indian districts; the authors find positive and significant spillover effects of urbanization across rural territories, rather than significant movements from rural poor population to urban areas. They argue that this poverty reduction effect of urbanization could be explained mostly by greater demand for local agricultural products, and also in a fewer extent by the increase of remittances and rural nonfarm employment. Although, there is still no study with causal evidence for the Colombian case, there is a negative relationship between urbanization ratio and poverty; in fact, the Spearman pair wise correlation between urbanization ratio and the multidimensional deprivation headcount reaches -0.46 points for 2005 census data and -0.167 points between urbanization and rural multidimensional deprivation headcount.

However, despite urbanization and multidimensional deprivation are in average negatively related, there is still a high dispersion at municipal level as shown in Figure 4.a below. There are some cases with very high level of urbanization and high levels of multidimensional poverty incidence; in fact, out of 1106 municipalities 27.9% exhibit an urbanization rate greater than 0.5 but also multidimensional deprivation headcount greater than 50%. All this suggests that the urbanization degree, i.e., the differences in the proportion of the population living in urban areas, is not sufficient to explain poverty variation across municipalities.

On the other hand, as the report of the World Bank (2009) emphasizes, as important as density, is distance to densities. Two municipalities can have the same density and the same urbanization rate, but if one of them is close to an important urban center and the other is far from any, the first municipality can, potentially, take advantage of the agglomeration economies associated with the nearby city. It

means, to take advantage of scale and specialization economies (for example manufacturing firms located around urban centers), network economies, pooling or clustering of economic resources, learning economies, etc.

Indeed, (i) density and (ii) distance to density could be analyzed, as suggested by Machado (2011), as a joint phenomena by aggregating them into one indicator, a rurality index. In fact and following Machado (2011) we combine population density and four variables of distances to densities in a measure that is called "Rurality Index" (RI) [8] because what we intent to capture is the underlying concept of rurality more than each of its components.

As can be seen in Figure 4b, we found a strong positive relationship between incidence of multidimensional deprivation and the rurality degree of a municipality: less rural municipalities tend to have a lower incidence. More rural municipalities tend to have a higher incidence. However, in the middle range there can be observed a high dispersion of poverty incidence between municipalities with similar rurality degree[9].

It is worthy to note that most of the municipalities with lower rurality degree are part of what can be called the Colombia's "System of Cities". It comprises the main cities of the country larger than 100.000 habitants and their agglomerations. The System of Cities comprises 151 municipalities, 56 of which are larger than 100,000 habitants (BM and DNP, 2012)[10]. In 2010 the municipalities within the System of Cities represented 66% of total population, 80% of urban population and 81% of formal employment[11].

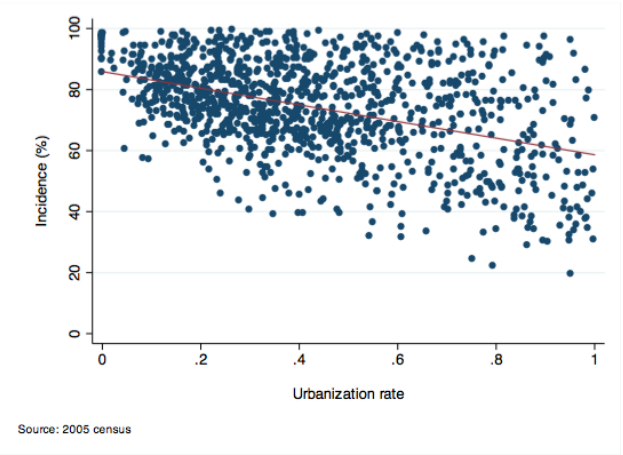
[8] To obtain the proposed RI for each $n$-municipality, we first aggregate into one indicator ($Average\ Dist_n$), the following four meaningful distances: (i) distance to the closest municipality of at least a million inhabitants; (ii) distance to the closest municipality between 400 and 1000 thousand inhabitants; (iii) mean distance to municipalities between 200 and 399 thousand inhabitants and (iv) mean distance to the 50% closest municipalities between 100 and 199 thousand inhabitants. Second, we express $Density_n$ as the number of inhabitants per squared kilometer in each $k$-municipality. Third, we obtain a first stage rurality index for each municipality as $RI_n = ln(Average\ Dist_n / Density_n^2)$ and finally we expressed the $RI_n^*$ definite rurality index for each municipality $n$ as a relative function of the first stage $RI_n$ for each municipality and the distribution of it across all N municipalities as follows: $RI_n^* = 100\left[\frac{RI_n - min(RI_n)}{max(RI_n) - min(RI_n)}\right]$.

[9] Municipalities with the same RI could differ substantially in poverty terms due to differences in their endowment of natural resources, soil quality or the presence of non-renewable natural resources that act, in fact, as an economic density pole that attract capital and other productive resources. De Janvry and Sadoulet (2007) differentiates between "marginal rural areas" (MRA) and "favored rural areas" (FRA). MRA are those characterized by poor agricultural endowments, and isolated from markets and employment sources. Geographical isolation and the poor endowments convert these areas in true poverty traps. In contrast, FRA can be transformed in dynamic regions based on their comparative advantages, if they are effectively and efficiently connected with their relevant markets.

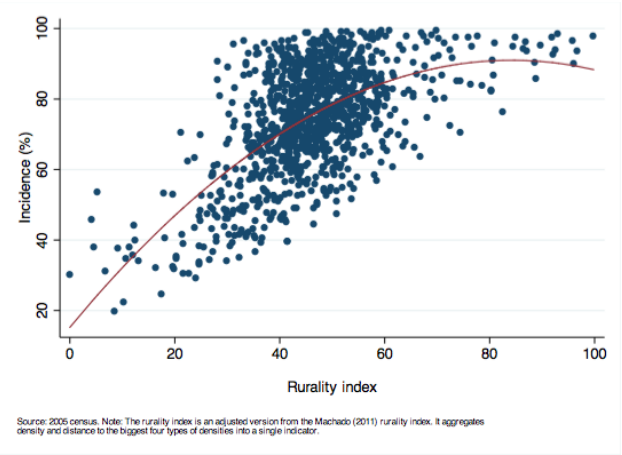
[10] The identification of the System of Cities in Colombia has been an analytical and empirical exercise carried out by the Mission of System of cities (BM & DNP, 2012). It was based in the identification of functional relationships between centers of agglomerations and their surroundings using indicators such as commuting, daily traffic flows, and travel times.

[11] Source of population figures, Dane; and PILA 2005 for employment figures.

**Figure 4. Dispersion of incidence of multidimensional deprivation across urbanization rate and rurality index**




a) Urbanization and multidimensional poverty




b) Rurality index and multidimensional poverty

## 7. Empirical Strategy

Given that multidimensional deprivation is not randomly allocated across the national territory (as was illustrated in Figure 2.b when describing our conceptual background), estimation procedures need to take explicitly into account the existence of spatial correlation. Therefore, we use a spatial econometric approach, as has been done in the literature for a wide variety of economic related topics as house pricing, violence and crime, social movements, and political science issues, among others; examples of these are studies such as Ioannides (2002), Mears and Bhati (2006), Swaroop and Morenoff (2006) and Franzese and Hays (2008), respectively.

As some econometric and statistical textbooks state, ignoring the spatial dependence across observations of the dependent variable by estimating an Ordinary Least Squares (OLS), or even when using a fixed effect model, produces inefficient and inconsistent estimators of the coefficients and the sampling variance, on top of that, is also bias and underestimated; conducting this to have overestimated $R^2$, $t$ and $F$ statistics. In case that spatial dependence only affects the model's errors yet the estimators will be unbiased but inefficient (Arbia, 2006; p.90, Wooldridge, 2002; p.134).

Traditionally, two kinds of specifications have been used to consider spatial interdependence. The first one is the spatial autoregressive model (SAR), introduced by Cliff and Ord (1981). This specification accounts for the existence of spatial spillovers in the dependent variable. This specification considers this interaction among data via the introduction of a spatial lag in the right-hand-side of the model representing the relation of each observation with the neighboring outcomes. Excluding this spatial lag in the presence of spatial autocorrelation in the dependent variable, implies an omitted variable

problem. The second most well-known specification for spatial econometrics is the spatial autoregressive error model, the SARE; this model accounts for spatial dependence on the disturbances. However, even though the SARE model accounts for spatial correlation, the expected value of the dependent variable in a model like this one is the same than in a traditional OLS; meaning that this model excludes by construction any possibility of spillover effect, and for sufficiently large samples the estimators for this kind of model are equal to the OLS ones.

A generalized version of the aforesaid two specifications is the spatial autoregressive model with spatial autoregressive disturbances (SARAR), proposed by Anselin and Florax (1995). The SARAR model while accounts for spillover effects also it does for spatial autocorrelation of the errors (correlation among unobservables), both at the same time.

Due to the features of our data and our interest to understand multidimensional deprivation as an economic geography phenomenon with probably spillovers across geographical units, we focus our interest on a specification that allows us to test at the same time the spillover effect from neighbor municipalities and to take properly into account the correlation across spatial units among unobservables, a SARAR specification. The SARAR model can be described as follows:

$$y_i = \lambda \sum_{j=1}^{n} W_{ij} y_j + \sum_{k=1}^{h} \beta_k x_{ik} + \varepsilon_i \quad [1]$$

$$\varepsilon_i = \rho \sum_{j=1}^{n} M_{ij} \varepsilon_j + u_i \quad [2]$$

Where $y_i$ refers to our outcome of interest for the $i$th-municipality, the multidimensional headcount or it could be stated for the average multidimensional gap ($M1$) as well; $W$ and $M$ are the spatial weighting matrices; $\lambda$ and $\rho$ are the spatial autoregressive parameters which account for the intensity of the spatial correlation, the first one in terms of the lagged values of the dependent variable ($y_j$); *i.e* the value of the dependent variable but in the neighbor municipalities; and the second one in terms of the spatial autocorrelation given by unobservables ($\varepsilon_j$); finally $u_i$ refers to the remaining error term which is assumed independently and identically distributed. Additionally, this specification includes a set of $h$ independent variables for each municipality ($x_{ik}$), and a set of parameters related to them ($\beta_k$). According to this specification, if $\rho = 0$ we are in presence of a spatial autoregressive model; in turn if $\lambda = 0$ the specification gets reduced to the SARE model; and if both parameters are equal to zero($\lambda = 0, \rho = 0$), it reduces to the linear regression model.

Since the spatial lag term $\left(\sum_{j=1}^{n} W_{ij} y_j\right)$ is endogenous because the double causality between it and the dependent variable, the estimation procedure must account for this in order to obtain consistent estimators. Then, in terms of the estimators, there are two different options for the SARAR model; the maximum likelihood estimator (ML) and the generalized spatial two-stage least squares (GS2SLS). But, as

Kelejian and Prucha (1999) pointed out, there is neither general statistical theory, nor large sample theory for the ML estimator. Therefore, we opt for implementing a GS2SLS estimator[12].

Besides the endogeneity that arises from the spatial lag term, we are concerned for the possible endogeneity coming from the decentralization variables that are indeed our main explicative variables of interest (see section IV for a full discussion on this regard). As a first measure to tackle this potential problem, we use the lagged values of such variables as a proxy of the contemporary ones; meaning that instead of using the 2005 values of them we use the 2003 registers. However, this ad-hoc solution for our main parameter of interest could have not only problems of interpretability or precision; also does not allow us to test further whether the solution dealt properly with the problem or not. Then, beyond that, we found statistical evidence that indicated us that our main parameter of interest (taxation ability) is not exogenous yet; this, by performing a Durbin-Wu-Hausman test[13], which uses as null hypothesis exogeneity of tax ability and rejecting such hypothesis under a 1% of statistical significance.

For this specific case where there is evidence of endogeneity from one of the explicative covariates in the context of the SARAR model described previously, Drukker et al (2013) developed the IV-SARAR model, which can be specified as follows:

$$y_i = \lambda \sum_{j=1}^{n} W_{ij} y_j + \sum_{k=1}^{h} \beta_k x_{ik} + \sum_{s=1}^{q} \theta_s z_{is} + \varepsilon_i \qquad [3]$$

$$\varepsilon_i = \rho \sum_{j=1}^{n} M_{ij} \varepsilon_j + u_i \qquad [4]$$

Where, in comparison with Equations [1] and [2], there is an additional term composed by $\sum_{s=1}^{q} \theta_s z_{is}$, which refers to a set of potentially endogenous explicative variables ($z_{is}$) and the parameters related to them ($\theta_s$). We estimate the IV-SARAR specification. Within such specification $y_i$ is still our dependent variable of multidimensional deprivation; our $z_i$ endogenous explicative variable is taxation ability for the $i$th-municipality, the $x_k$ set is form by the other decentralization measures[14] and our set of controls, such as the rurality index, the urbanization rate, a dummy of population size that distinguishes between municipalities under 30 thousand inhabitants and over 30 thousand inhabitants, a dummy variable that specifies whether a municipality belongs to the Colombian System of Cities mentioned before, and other variables to account for the variability induced by the spread of violence in the territory, demographic characteristics and investments of the National Government done over the municipalities to alleviate poverty, such as the conditional cash transfer program '*Familias en Acción*'. Table 4 within the Annexes reports the descriptive statistics for all these particular controls.

[12] In particular, as proposed by Kelejian and Prucha (1999), Kelejian and Prucha (2004), and Arraiz (2010) for the SARAR model, we first use as valid instruments for the endogenous $W_H$, the spatial lags of the variables contained in $X$, then we estimate the instrumented specification by the generalized-method-of-moments and finally we perform a spatial Cochrane-Orcutt transformation to obtain more efficient estimates for $\beta$ and $\lambda$.

[13] For a comprehensive explanation of the Durbin-Wu-Hausman test see Cameron (2005).

[14] The different decentralization measures are included individually within the regression analysis to avoid loss of information.

As instrument for taxation ability we use the share of blank votes over the total votes for the local elections of 2003. The election of this instrument is based on the argument that many citizens do not pay taxes because they hardly trust the political institutions, and their way to express this perception is by voting blank on the electoral process. In this regard, Persson and Tabellini (2003), when compiling several previous theoretical knowledge on the effect of political process over economic policymaking and empirically testing its behavior by the use of a large multi country data set, they argue for a clear relationship between electoral outcomes and policy decisions. On the other hand, the validity of our instrument is based on the absence of any theoretical linkage between poverty outcomes and the blank votes share, besides that, some previous evidence for the Colombian case has been considered; for example, Horbath (2004) studies the connection between electoral outcomes and poverty level at a county level, using data for the 2002 elections; he finds a systematic and strong correlation between some poverty measures and political participation, nevertheless, he does not find any correlation between the blank votes share and the same poverty measures.

Once we have explained the econometric model specifications that we test we move onto describe briefly the specification that we follow for the spatial weight matrix ($W$). Since the specification of $W$ is in general arbitrary, we use two relevant specifications of the matrix to test the validity of our results.

Our first specification of the weighting matrix is the most common used within the spatial econometric literature, which is a contiguity-based matrix. In this case, two municipalities are considered neighbors when their two geographical polygons are adjacent, meaning that they share a common boundary. However, this definition typifies pairs of municipalities by whether or not they are neighbors and does not necessarily capture economic geography or the intensity of their relationship. Then, the second matrix that we use not only describes the relationship between municipalities as being neighbors or not, it also follows an economic-based criteria and intents to capture the intensity of such connection. This, by taking into account the four following indicators: (i) Common boundary indicator, (ii) The inverse distance between municipalities that are not farther than 92 kilometers among each other, (iii) The per capita commutation process captured by the 2005 census and (iv) the per capita average daily traffic per kilometer, between 2002-2004 and reported within the national administrative registers of daily traffic. We aggregated those four components into a single indicator that ranges from 0 to 1 and that was constructed as an additively separable linear transformation from its components.

## 8. Econometric results

In this section we describe the main econometric results obtained from modeling the average multidimensional gap and the multidimensional deprivation headcount. The results presented below in Table 5, include the Ordinary Least Squares (OLS) and the SARAR estimations. For the latter we consider both specifications of the spatial-weighting-matrix, the contiguity based (S-Cont.) and the economic geography based (S-EG). Finally for each of these two latter specifications we estimate their instrumental variable version (S-IV-Cont and S-IV-EG). Table 5 below shows both, the estimation results of multidimensional average gap ($M1$) and the multidimensional headcount ratio ($H$). However, since

the results reported by our models do not correspond strictly to elasticities, at the beginning of this section we only analyze our results in terms of statically significance and sign; but, in order to produce more policy informative results, at the end of this section we present the estimated elasticity for our parameter of interest and some public policy counterfactual scenarios.

The classical OLS estimation for the case of M1 shows a 0.815 R2 and for the case of H a 0.784 R2. But, when we test for spatial spillovers of deprivation across municipalities we found a statistically significant effect (lambda coefficient) in all the proven specifications. This result confirms a strong spatial positive transmission effect of deprivation across neighboring municipalities that should be taken into account when designing public policy interventions. Worth to note that the specifications that use the economic geography based matrix to depict the spatial interrelation among municipalities in general, across the different tested specifications, always register greater spillover effect than specifications that use a simple contiguity based relationship among municipalities.

Worth noting as well, that despite we control for possible unobservables that vary at the departmental level thought a set of 32 county dummies, we still find positive and statistical significant geographical effects in the error term (Rho coefficient); coefficient that in magnitude is always smaller when using the economic geography based matrix than when using the contiguity based one. This result along to the results concerning to the lambda coefficient confirms that understanding deprivation as a geographical phenomenon is required and public policies consistent with those patterns need to be designed. Moreover, modeling the relationship among municipalities using only a contiguity relationship among municipalities could downwards bias the geographical effects. Then, operationalizing the municipalities relationship in economic based terms rather than by a simple contiguity based relationship seems to capture in a better manner the deprivation geographical pattern.

In terms of the decentralization variables, when regressing our two outcomes of interest against the set of measures of fiscal, administrative and political decentralization, we found a negative and statistical significant effect of fiscal, administrative and political decentralization over both M1 and H (models (1) to (3) within Table 4 below). However, such effect looses significance once we introduce our set of controls; but interestingly our decentralization variable of interest, taxation ability, remains significant across all specifications for both outcomes.

Furthermore, when cleaning the endogeneity embedded over fiscal decentralization, measured by the resources per capita, we still found a statistically significant effect that even becomes duplicated its value after accounting for such endogeneity (models (7) and (8)). Those results suggest that in average Colombian municipalities get improved its social equity and reduced its deprivation headcount as a result of their greater taxation ability. Notice that this result holds when controlling in particular for administrative ability, economic activity (business per urban squared km) and all the other covariates.

## Table 5. Determinants of multidimensional headcount ratio and gap

| | Multidimensional average gap (M1) | | | | | | | | Multidimentional deprivation headcount ratio (H) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS (1) | S-Cont (2) | S-EG (3) | OLS (4) | S-Cont (5) | S-EG (6) | S-IV-Cont (7) | S-IV-EG (8) | OLS (1) | S-Cont (2) | S-EG (3) | OLS (4) | S-Cont (5) | S-EG (6) | S-IV-Cont (7) | S-IV-EG (8) |
| Taxation ability | -0.002*** | -0.001*** | -0.002*** | -0.001*** | -0.001*** | -0.001*** | -0.003*** | -0.002*** | -0.060*** | -0.032*** | -0.045*** | -0.032*** | -0.022*** | -0.022*** | -0.089*** | -0.062*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) | (0.006) | (0.008) | (0.008) | (0.004) | (0.006) | (0.005) | (0.025) | (0.015) |
| SGP CMPI | 0.000 | -0.000 | 0.000 | -0.000 | -0.000 | -0.000 | -0.000 | 0.000 | 0.010 | -0.001 | 0.009 | 0.006 | -0.001 | 0.004 | 0.004 | 0.006 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.006) | (0.007) | (0.008) | (0.004) | (0.004) | (0.004) | (0.007) | (0.005) |
| SGP NON CMPI | 0.002*** | 0.002*** | 0.002*** | -0.000 | -0.000 | -0.000 | 0.000 | 0.000 | 0.044*** | 0.041*** | 0.048*** | -0.004 | 0.005 | 0.004 | 0.010 | 0.008 |
| | (0.000) | (0.001) | (0.001) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.010) | (0.013) | (0.015) | (0.007) | (0.007) | (0.006) | (0.009) | (0.008) |
| Royalities CMPI | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.005 | 0.002 | 0.002 | 0.003 | 0.000 | -0.001 | 0.005 | 0.002 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.009) | (0.007) | (0.008) | (0.006) | (0.004) | (0.004) | (0.005) | (0.004) |
| Royalities NO CMPI | -0.000 | -0.000 | -0.000 | -0.000 | -0.000** | -0.000** | -0.000 | -0.000* | -0.002 | -0.002 | -0.001 | -0.003 | -0.002 | -0.001 | -0.001 | -0.001 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.005) | (0.002) | (0.002) | (0.003) | (0.001) | (0.001) | (0.002) | (0.002) |
| Administrative ability | -0.007*** | -0.004*** | -0.004*** | -0.001 | -0.001 | -0.000 | -0.000 | -0.000 | -0.147*** | -0.088*** | -0.082*** | -0.025 | -0.018 | -0.008 | -0.002 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.027) | (0.027) | (0.024) | (0.018) | (0.016) | (0.015) | (0.017) | (0.015) |
| Political desc. | -0.010*** | -0.006*** | -0.006*** | -0.004*** | -0.003*** | -0.003*** | -0.003*** | -0.003*** | -0.128*** | -0.067** | -0.071*** | -0.021 | -0.008 | -0.013 | 0.000 | -0.007 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.030) | (0.027) | (0.025) | (0.022) | (0.020) | (0.019) | (0.021) | (0.019) |
| Rural Index | | | | 0.009*** | 0.006*** | 0.005*** | 0.006*** | 0.005*** | | | | 0.207*** | 0.150*** | 0.166*** | 0.145*** | 0.152*** |
| | | | | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | | | | (0.040) | (0.037) | (0.039) | (0.042) | (0.039) |
| Urbanization | | | | -0.008*** | -0.009*** | -0.009*** | -0.008*** | -0.009*** | | | | -0.160*** | -0.179*** | -0.187*** | -0.165*** | -0.179*** |
| | | | | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | | | | (0.014) | (0.014) | (0.013) | (0.016) | (0.014) |
| Pop. Size | | | | -0.095** | -0.122*** | -0.126*** | -0.125*** | -0.129*** | | | | -3.735*** | -3.962*** | -3.842*** | -4.097*** | -3.980*** |
| | | | | (0.039) | (0.041) | (0.040) | (0.042) | (0.041) | | | | (0.840) | (0.809) | (0.765) | (0.862) | (0.783) |
| System of cities | | | | -0.059 | -0.039 | -0.109*** | -0.000 | -0.073 | | | | -2.512*** | -1.760* | -3.874*** | -0.589 | -2.844** |
| | | | | (0.042) | (0.042) | (0.042) | (0.047) | (0.047) | | | | (0.907) | (1.039) | (0.995) | (1.210) | (1.112) |
| National program | | | | 0.000*** | 0.000*** | 0.000*** | 0.000*** | 0.000*** | | | | 0.004*** | 0.003*** | 0.002*** | 0.002** | 0.002** |
| | | | | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | | | | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Business per urban km2 | | | | -0.002*** | -0.001*** | -0.001*** | -0.001*** | -0.001*** | | | | -0.064*** | -0.039*** | -0.030*** | -0.031*** | -0.026*** |
| | | | | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | | | | (0.007) | (0.011) | (0.009) | (0.011) | (0.009) |
| Roads per Km2 | | | | -0.012 | -0.027** | -0.030** | -0.028** | -0.031** | | | | 0.186 | -0.052 | -0.043 | -0.083 | -0.101 |
| | | | | (0.015) | (0.012) | (0.012) | (0.013) | (0.012) | | | | (0.335) | (0.296) | (0.287) | (0.352) | (0.309) |
| Agro-concentration | | | | -0.038 | -0.004 | -0.004 | -0.020 | -0.016 | | | | -0.314 | 0.581 | 0.671 | -0.031 | 0.307 |
| | | | | (0.028) | (0.025) | (0.025) | (0.027) | (0.026) | | | | (0.616) | (0.570) | (0.579) | (0.655) | (0.619) |
| Attacks | | | | -0.000 | -0.000 | 0.001 | 0.000 | 0.001 | | | | 0.008 | 0.012 | 0.031** | 0.019 | 0.032* |
| | | | | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | | | | (0.018) | (0.016) | (0.015) | (0.021) | (0.016) |
| Share of population betweer | | | | 1.827*** | 1.873** | 1.908** | 2.000** | 1.923** | | | | 46.074*** | 50.011*** | 58.542*** | 53.134*** | 57.857*** |
| | | | | (0.682) | (0.901) | (0.812) | (0.928) | (0.821) | | | | (14.815) | (15.358) | (13.944) | (16.261) | (14.286) |
| Share of population under 5 | | | | 9.202*** | 8.057*** | 6.854*** | 8.326*** | 7.091*** | | | | 142.313*** | 123.692*** | 97.730*** | 131.705*** | 103.355*** |
| | | | | (0.733) | (0.884) | (0.842) | (0.918) | (0.870) | | | | (15.905) | (14.622) | (14.353) | (15.946) | (14.426) |
| Constant | 3.059*** | 1.092*** | 0.670*** | 1.384*** | 0.950*** | 0.549*** | 0.990*** | 0.589*** | 84.109*** | 23.055*** | 10.936** | 53.471*** | 33.428*** | 13.013** | 37.978*** | 17.034*** |
| | (0.107) | (0.199) | (0.171) | (0.176) | (0.197) | (0.185) | (0.209) | (0.188) | (2.296) | (6.858) | (5.199) | (3.824) | (5.619) | (5.147) | (5.917) | (5.137) |
| *....Controling by county dummies (32 counties).....* | | | | | | | | | | | | | | | | |
| Observations | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 |
| R-squared | 0.564 | | | 0.815 | | | | | 0.506 | | | 0.784 | | | | |
| Lambda | | 0.731*** | 0.912*** | | 0.279*** | 0.515*** | 0.234*** | 0.486*** | | 0.781*** | 0.945*** | | 0.309*** | 0.595*** | 0.225*** | 0.540*** |
| | | (0.053) | (0.054) | | (0.053) | (0.053) | (0.058) | (0.056) | | (0.067) | (0.061) | | (0.075) | (0.061) | (0.074) | (0.061) |
| Rho | | -0.485*** | -0.342*** | | 0.201*** | 0.263** | 0.178*** | 0.181 | | -0.474*** | -0.028 | | 0.245*** | 0.590*** | 0.195*** | 0.512*** |
| | | (0.092) | (0.127) | | (0.072) | (0.119) | (0.064) | (0.136) | | (0.103) | (0.148) | | (0.078) | (0.071) | (0.059) | (0.086) |

In particular, an average increment of one thousand Colombian pesos in per capita terms from own resources across the 1060 municipalities under study, produces 0.134 percentage points of average reduction in the multidimensional poverty headcount. Out of those 0.134 points of reduction, 0.62 points of them come from the direct effect that this additional unit of own resources produces and the remaining 0.72 points are product of the spillover effect that those resources produce. Table 6 below reports the total impact of taxation ability over our two outcomes of interest, decomposed by direct and indirect effects. Consequently, our results suggest that public policies that seek to strength the municipality fiscal capacity have significant effectiveness when trying to reduce multidimensional deprivation and achieve convergence to social minimums.

**Table 6. Decomposition of the total impact of taxation ability across direct and indirect**

| | Direct effect | Indirect effect | Total effect |
|---|---|---|---|
| Multidimensional average gap | -0.002*** | -0.002*** | -0.004*** |
| | (0.0001) | (0.0008) | (0.0006) |
| Multidimensional headcount ratio | -0.062*** | -0.072*** | -0.134*** |
| | (0.001) | (0.002) | (0.011) |

In contrast, policies oriented to transfer resources from the central government to the territories do not show statistical significance in any of the final models. As can be seen from all our proven specifications, governmental transfers for CMPI related expenditures (education, health and drinkable water and sanitation) do not have statistically significant effect, neither on the multidimensional average gap nor on the multidimensional headcount ratio; this not even before introducing the set of controls and correcting for spatial correlation. This result reinforces that despite governmental transfers to CMPI related uses have the explicit purpose of decreasing the coverage gap in education, health, drinkable water and sewerage, they do not significantly reduce such gap as much as a the own effort of municipalities to produce its own resources.

In addition, governmental transfers for other uses as well as royalties do not appear to have a significant effect on multidimensional deprivation. Consequently, the design of governmental transfers and their allocation need to be further studied and analyzed in order to improve its equalizing purposed. Notice that in previous proven specifications we test the aggregated version of the transfers to municipalities and this variable still in such specification do not register statistical significance.

On the contrary, the degree of political participation has a strong and robust negative effect on both, poverty incidence and poverty gap: municipalities with higher participation of citizens in the electoral process tend to have lower multidimensional poverty incidence, and their population under poverty tend to be less poor than municipalities with lower political participation. However, for the case of multidimensional headcount this effect disappears when introducing our set of covariates. Then, political decentralization seems to be playing a more important role on reducing the gap on the achievement of social minimums rather than preventing deprivation.

On the other hand, administrative capacity of local administration, as expected, reduces statistically significantly the gap to achieve social minimums, but the strength of this effect diminishes after controlling for spatial correlation and it gets rolled out after controlling for our set of covariates. It is possible, in fact, that those municipalities with a higher local administrative capacity are the ones with a higher share of own resources.

### a. Counterfactual policy scenarios

We test two alternative policies to determine the relative effectiveness of geographically differentiated decentralization policies against a policy that do not take into account the geographical relationship among municipalities. The first counterfactual scenario (Policy A) corresponds to a non-geographically designed policy, which produces an increment of 1.48% of the per-capita own resources per each municipality in the country. The geographically sensitive policy, on the other hand, is expressed in two scenarios: One, focused on main urban areas (Policy B) concentrates the same fiscal effort over the centroids of the national system of cities, which corresponds to an increment of 2.61% of per-capita own resources in each of the 18th cities in the country with an spatial agglomeration around them. The second policy (Policy C) concentrates the same fiscal effort over 303 municipalities that do not belong to the System of Cities but that are the most spatially correlated; this Policy C would mean a 20% direct increment of the per capita own resources in those municipalities.

Table 7 below presents the mean simulated change effect from each tested policy over multidimensional deprivation. Column (1) reports the mean effect of each policy over the total 1060 municipalities, column (2) the effect of each policy over the set of $18^{th}$ system of cities' centroids, column (3) the effect of each policy over the set of 303 most interrelated municipalities but that do not belong to the System of Cities; and column (4) the result over the remaining 739 municipalities. As can be seen, when comparing the effect produced by Policy A, B and C, on either $H$ or $M1$, the same fiscal effort concentrated in the 18 cities would produce a greater mean reduction in the mean multidimensional headcount ratio across all municipalities than spreading the fiscal effort over all the municipalities. However, the largest impact on poverty reduction is obtained with, policy C (Column 1); notice that such a policy has an effect of 0.21 percentage points poverty reduction over the 739 other municipalities that were not subject of the policy, just as a product of the spillover effect.

These policy simulations illustrate the direct and indirect effects of the introduction of the same fiscal effort on own resources, but its differentiated effect regarding the targeted municipalities. The results suggest that policies targeted by geographically correlations criteria might produce more effective results than policies that do not take into account this important feature of multidimensional deprivation.

**Table 7. Mean change effect of each simulated policy over multidimensional deprivation**

| | | | All municipalities (1) | The 18th Centroids (2) | The 303 most correlated municiplaities (3) | Others (4) |
|---|---|---|---|---|---|---|
| H | Simple mean | | 69.455 | 34.146 | 75.925 | 67.371 |
| | | | (0.4909) | (1.5505) | (1.0348) | (0.4847) |
| | Difference | Policy A | 0.0921*** | 0.1859*** | 0.0676*** | 0.0999*** |
| | | | (0.0017) | (0.0111) | (0.0029) | (0.0019) |
| | | Policy B | 0.0058*** | 0.1061*** | -0.0011 | 0.0063*** |
| | | | (0.0008) | (0.0088) | (0.0011) | (0.0009) |
| | | Policy C | 0.2852*** | 0.0956 | 0.4772*** | 0.2110*** |
| | | | (0.0102) | (0.0702) | (0.0186) | (0.0111) |
| M1 | Simple mean | | 0.2466 | 0.1155 | 0.2948 | 0.2280 |
| | | | (0.0027) | (0.0075) | (0.0063) | (0.0024) |
| | Difference | Policy A | 0.0028*** | 0.0057*** | 0.0021*** | 0.0031*** |
| | | | (0.0001) | (0.0003) | (0.0001) | (0.0000) |
| | | Policy B | 0.0002*** | 0.0032*** | -0.0000 | 0.0002*** |
| | | | (0.0000) | (0.0003) | (0.0000) | (0.0000) |
| | | Policy C | 0.0087*** | 0.0029 | 0.0146*** | 0.0065*** |
| | | | (0.0003) | (0.0021) | (0.0006) | (0.0003) |

### b. Other interesting results

Economic geography variables have a significant effect on multidimensional deprivation with the expected sign: more rural municipalities (measured by the Rurality Index) tend to have a higher multidimensional headcount ratio and a higher multidimensional average gap. It means that municipalities with lower population density and/or more distant to cities with more than 100 thousand habitants are, in average, more deprived than other municipalities; and that their multidimesionally deprived population is in average farther to achieve those social minimums than the other municipalities.

At the same time, the urbanization ratio (i.e., the share of population living in the urban area of the municipality) has a negative effect on both, multidimensional headcount and gap. Additionally, municipalities with more population have lower multidimensional deprivation headcount and gap. There is, also, an *additional* negative effect on multidimensional poverty incidence for those municipalities that belong to the System of Cities as defined in previous sections. This means that to be part of the System of Cities in Colombia is a "bonus" to decrease poverty incidence; although this effect is not statistically significant for the case of the multidimensional gap.

On the other hand, there is negative effect of formalization on both outcomes of interest, measured by the number of formal firms per square kilometers in the urban area. Both effects remain even after controlling the potential endogeneity of fiscal decentralization variable by using IV.

It is interesting to note that the variable (primary and secondary) roads per square kilometer has a significant negative effect on the average multidimensional gap although this variable does not appear significantly related with the multidimensional deprivation headcount. It means that those municipalities with a larger number of kilometers of primary and secondary roads per square kilometer tend to have a "less poor" population than other municipalities with a smaller number of roads per square kilometer[15].

Finally, the most important national program of conditional cash transfer to alleviate poverty (Familias en Acción) appears positively and significantly related with both multidimensional deprivation and gap but with less extent for the gap. This results probably reflects the targeting of the program in the poor population which, as we have seen, is not randomly distributed in the space but tend to concentrate in some regions more than in others.

## 9. Concluding remarks

Colombia's decentralization was conceived to improve population's access to social services, reduce poverty and equalized well-being across the territory. However, after more than 20 years of its implementation a big gap in social achievements across municipalities remains. The main goal of this paper was to disentangle the effect of decentralization on multidimensional poverty incidence and gaps at municipal level in Colombia and its success or failure to overcome economic geography issues that emerge from a very heterogeneous territory. We assess the causal effect of taxation ability, measured as the per capita municipal own resources, over multidimensional deprivation, a variable that has strong spatial correlation. To address this task we model poverty as a phenomenon with spatial interactions,

[15] Due to data limitations, it was not possible to include tertiary roads, a variable that probably has a stronger relationship with multidimensional deprivation, mainly in the rural sector (see Villar and Ramírez, 2014).

and we use a spatial econometric approach that accounts for spillover effects and for spatial correlation of the errors, correcting also for potential endogeneity of the fiscal decentralization variable.

We found that deprivation is in fact a spatial issue. Multidimensional poverty is not randomly distributed in the territory but tend to concentrate in some regions more than in others; moreover, our results imply a strong spillover effect of deprivation across municipalities. Therefore, strategies to overcome poverty need to be complemented with a territorial approach and take into account that deprivation is strongly defined by geographical interactions as well.

The results of the econometric estimations show that the municipalities per capita own resources have a strong negative causal effect over multidimensional deprivation, depicted by the average multidimensional gap and the multidimensional headcount as well. Additionally, political decentralisation, measured by citizen participation in local elections, has also a strong negative effect on poverty gap and incidence. However, governmental transfers show a no statistically significant result over, neither average gap of deprivation nor incidence.

Geography is relevant to explain multidimensional incidence and gap. Higher incidence and gap are associated with: a) a higher degree of rurality (lower densities and/or larger distances to densities); b) a lower urbanization rate; c) municipalities that are not part to the Colombian System of Cities. These results support the conclusion that the main difference in terms of poverty in Colombia is not between urban and rural areas, but between municipalities with high densities or close to towns with high densities, and municipalities with low densities and far from towns with high densities. The estimations also show a very strong negative effect of formalization on poverty incidence, measured by the number of formal firms per square kilometers in the urban area, and in a less extent on poverty gap.

Spatially differentiated policies and decentralization designs that take into account the heterogeneity of regions and municipalities are definitely required in order to improve social convergence to minimums from the territories at the bottom of the distribution, and the role of economic geography variables should be taken into account in the design of such policies. In particular, Colombia has a pending agenda to decrease rural poverty (in the sense depicted by the Rurality Index). However, further research is still needed to address heterogeneous effects by sets of municipalities given their rurality levels.

The findings of the paper also suggest some topics that should be part of an agenda for adjusting and reforming the decentralization model in Colombia. One of them is the need to strengthen the subnational revenue system to increase the share of own generated resources by municipalities. In practical terms, the focus of this policy should be municipalities with relative larger geographical interconnection with their neighbours. Cities should be given more autonomy and more capability to increase their own resources, and to set its own programs with the correspondent responsibility toward their own citizens. In order to increase the share of own resources at subnational level a reform in the design of the transfer system is in order, as has been extensively discussed by Bird (2012). The purpose in this case is the design a transfer system that takes into account the potential revenue-raising capacity of each municipality and does not disincentive its own fiscal effort.

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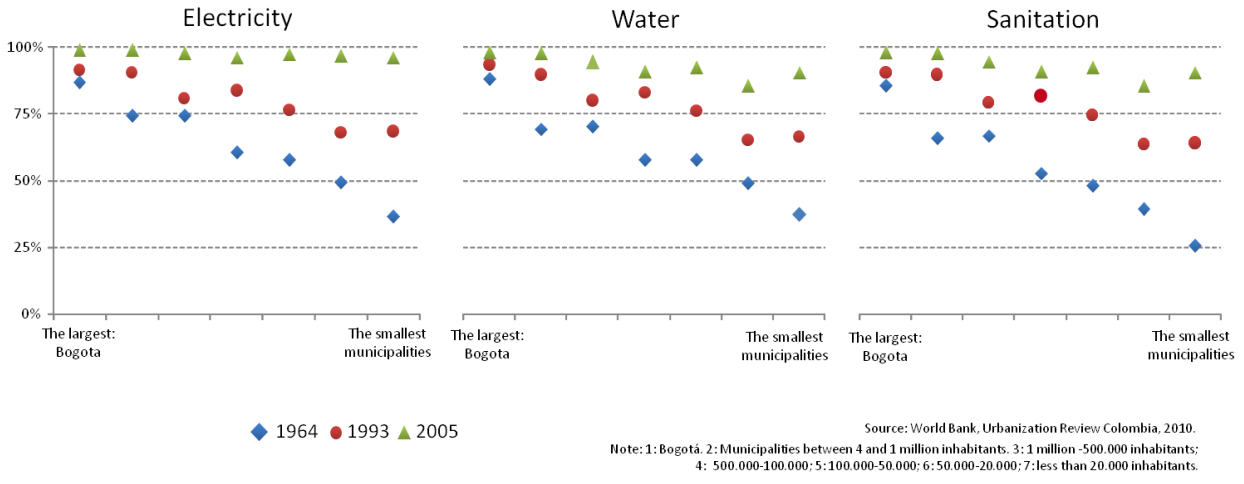
## Annexes

### Table 1. Governmental investment structure by levels of government, 2010

| | Billions of 2010 Colombian pesos | | | | (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | Central government | Counties | Municipalities | Total | Central government | Counties | Municipalities | Total |
| **Total Investment** | **22.2** | **15.4** | **33.0** | **70.5** | **0.31** | **0.22** | **0.47** | **1.00** |
| **CMPI related investment** | **11.5** | **12.3** | **24.2** | **47.9** | **0.24** | **0.26** | **0.51** | **1.00** |
| Education | 1.0 | 7.3 | 9.2 | 17.5 | 0.06 | 0.42 | 0.53 | 1.00 |
| Health | 1.6 | 3.3 | 9.1 | 14.0 | 0.12 | 0.24 | 0.65 | 1.00 |
| Attention to vulnerable groups, social promotion | 6.2 | 0.3 | 1.2 | 7.8 | 0.80 | 0.04 | 0.16 | 1.00 |
| Dwelling | 0.7 | 0.2 | 0.7 | 1.6 | 0.44 | 0.12 | 0.44 | 1.00 |
| Drinking water and basic sanitation | 0.3 | 1.0 | 3.5 | 4.8 | 0.06 | 0.21 | 0.73 | 1.00 |
| Public services different from water and | 1.7 | 0.1 | 0.4 | 2.2 | 0.74 | 0.06 | 0.20 | 1.00 |
| **Other non-CMPI related investment** | **10.7** | **3.1** | **8.8** | **22.6** | **0.47** | **0.14** | **0.39** | **1.00** |

Source: National Planning Department, 2010 administrative fiscal registers

### Figure 3: Percentage of urban population with access to public services across type of municipalities




Source: World Bank, Urbanization Review Colombia, 2010.
Note: 1: Bogotá. 2: Municipalities between 4 and 1 million inhabitants. 3: 1 million -500.000 inhabitants; 4: 500.000-100.000; 5: 100.000-50.000; 6: 50.000-20.000; 7: less than 20.000 inhabitants.

**Figure 4: The System of Cities in Colombia**

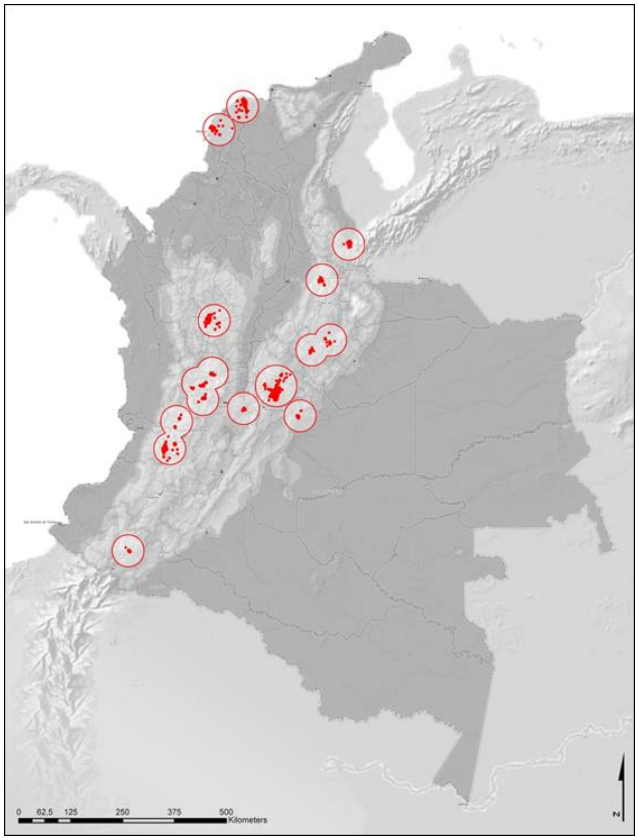



**Table 4. Descriptive statistics: controls**

| Control variables | | N | Mean | Std. dev | Min | Max | Units | Source |
|---|---|---|---|---|---|---|---|---|
| Location and size | Urbanization | 1111 | 43.10 | 24.70 | 0.00 | 100.00 | Percentual share (0-100) | 2005 Census |
| | Population size | 1111 | 0.06 | 0.23 | 0.00 | 1.00 | Dummy, 1= Municipality with 30.000 or more inhabitants. 0= Municipalities with less than 30.000 inhabitants. | 2005 Census |
| | System of cities | 1111 | 0.14 | 0.34 | 0.00 | 1.00 | Dummy, 1=belongs to the system of cities. 0= Do not belong | System of cities mission |
| | Rurality Index | 1111 | 46.68 | 12.58 | 0.00 | 100.00 | Index from 0 to 100 | Based on UNDP, 2011 |

| Control variables | | N | Mean | Std. dev | Min | Max | Units | Source |
|---|---|---|---|---|---|---|---|---|
| | a. Population density | 1092 | 140.59 | 576.70 | 0.16 | 10682.55 | Inhabitants per squared kilometre | 2005 Census |
| | b. Distance to the closest municipality of at least a million inhabitants | 1092 | 165.88 | 102.90 | 0.00 | 955.54 | kilometres | Euclidean distances based on map information |
| | c. Distance to the closest municipality between 400 - 1000 thousand inhabitants | 1092 | 151.07 | 117.49 | 0.00 | 980.37 | kilometres | |
| | d. Mean distance to municipalities between 200 and 399 thousand inhabitants | 1092 | 399.12 | 107.81 | 270.41 | 1147.87 | kilometres | |
| | e. Mean distance to the 50% closest municipalities between 100 and 199 thousand inhabitants | 1092 | 244.72 | 84.94 | 155.61 | 1007.62 | kilometres | |
| Conectivity | Kilometres of primary and secondary roads per squared kilometres of the municipality | 1096 | 1.23 | 0.88 | 0.00 | 13.33 | kilometres | IGAC and System of cities |
| Economic density | Business per urban squared km | 1111 | 28.66 | 43.55 | 0.00 | 396.18 | # of business per urban squared kilometre | PILA and IGAC. |
| | Agro-concentration | 1111 | 0.20 | 0.40 | 0.00 | 1.00 | Dummy, 1=municipalities with greater concentration of agricultural activity. 0=municipalities without agricultural vocation | NPD |
| Other controls | Violence. Number of attack from FARC, ELN and paramilitary groups from 1998-2002 | 1111 | 7.34 | 15.70 | 0.00 | 219.00 | Number | National Police |
| | Central government investment. Number of beneficiary families to the national conditional cash transfer program: Familias en Acción | 1111 | 178.67 | 306.60 | 0.00 | 2609.27 | Number | NPD, 2003 |
| | Demographic vulnerability. Average share of children, women and elderly at home | 1111 | 52.60 | 20.50 | 0.00 | 100.00 | Percentage share (0-100) | UNDP, 2011 |